The Examiner has objected to the title, as being not descriptive. Accordingly, the title has been amended to read "ACTUATOR WITH NON-ROTATING, REVOLVING MEMBER."

For the purposes of this discussion, the term revolve, as differentiated from the term rotate, will now be described with respect to the claimed invention. Figure 4 of the specification shows, in a series of images, the movements of a member 1 as it undergoes revolution motion, namely, as it revolves, according to a use of the term in the patent application. In the first image on the left of the figure, the member 1 is positioned in contact with a side of the stator or outer case 5a at a point at the extreme left of the case 5a and member 1. Pins 1a are immovably affixed to the member 1, to protrude from the upper surface thereof. Shafts 4 are rotatably fixed directly above the upper surface of the member, and have off-center holes to receive the pins 1a, which are rotatably positioned therein. as the member 1 moves from the position shown in the first image to that shown in the second, or middle image of Figure 4, the member 1 now makes contact with the case 5a at a point midway between the left side and the top of the case 5a. It may be observed that the shafts 4 have rotated as the pins 1a move with the member 1. Thus, the member 1 has undergone revolution motion, as compared to shaft 4 which has rotated about its axis. In the last image of Figure 4 the member 1 is touching the case 5a at the top, center. It has undergone further revolution motion from the prior position. The shafts 4 have continued to rotate as the pins 1a have moved with the member 1. It may be observed that the shafts 4 have each rotated on a respective axis while the member 1 remains oriented as it was in the first image. A line may be imagined as having been drawn on an upper surface of the member 1 vertically, from top to bottom. As the member 1 revolves, it is constrained from rotating on its own axis by the pins 1a and the shafts 4, such that, throughout a complete circuit or revolution of the member 1, the imaginary line will remain vertical.

The Examiner will recognize that English language words may have multiple meanings, and it is difficult to provide a commonly accepted term that refers unambiguously to the type of motion performed by the member 1, without confusion with the motion performed by the shafts 4. To avoid this confusion, applicants stated in the application as filed that the shafts 4 rotate, but member 1 revolves, namely, undergoes revolution motion, but it does not rotate. For the purposes of describing the claimed invention, applicants will use the terms rotate and rotation

to indicate axial motion about a central axis, as performed by the shafts 4. The terms revolve and revolution will be used to refer to a progressive motion of a body around a center such that any line of the body remains parallel to its initial position throughout the circuit or revolution, and to which it returns on completing the circuit, as will now be shown from the specification.

The specification clearly distinguishes these two types of motion. For example, a description beginning on page 5, line 17, of the specification, recites "a movable member 1 capable of parallel movement (revolution motion) with a predetermined revolution radius." Continuing on line 20 of the same page "an eccentric shaft 4 for preventing of the above-mentioned movable member 1 from rotating and for revolving it with the predetermined radius" is described. Page 6, line 1 begins a description of "a mechanism for restricting the motion of the movable member 1 to a revolution trajectory and also constraining its rotation." The specification repeatedly refers to various embodiments of "revolution" type actuators, as distinguished from rotating actuators, to distinguish them from rotating actuators. Clearly, the applicants has taken pains to make this distinction.

With respect to the operation of the inventive device, and the forces used to cause the member to perform the revolution motion, a discussion follows on the magnetic principle relied upon to achieve this end. The principle will be described below with reference to Figure 3.

When a uniform magnetic field with the magnetic flux density B is established in the direction of z, and a current i_1 is applied, parallel to the y-axis, to the conducting path 3a disposed parallel to the xy-plane, a Lorentz force Fx in the direction of x is generated at the conducting path 3a in accordance with Fleming's left-hand rule. When the AC current is applied to the conducting path 3a and the length of a conductor in the uniform magnetic field is denoted by l, the current i_1 and the force Fx are formulated as follows:

$$i_1 = I\cos(\omega t + \phi)$$

$$F_x = i_1 Bl = IBl\cos(\omega t + \phi)$$

Note that the force Fx is linear rather than axial.

The equation of motion is formulated as follows:

$$F_x = ma = m\frac{d^2x}{dt^2}$$

Here, m and a represent the mass and acceleration respectively. Assume that when the time t equals zero, x and dx/dt also equal zero, the position x of the conducting path 3a is represented by the following equation by solving the differential equation.

$$x = \frac{IBl}{m}\left\{-\frac{\cos(\omega t+\phi)}{\omega^2} - \frac{\sin\phi}{\omega}t + \frac{\cos\phi}{\omega^2}\right\}$$

It may be understood from the above that the conducting path 3a performs a simple harmonic motion in the direction of x.

While the conducting path 3b is arranged in the same plane, or in a plane parallel to that of the conducting path 3a, conducting path 3b is arranged with an axial shift of 90 degrees. When a current i_2, 90 degrees out of phase with respect to the current i_1 is applied to the conducting path 3b, a linear force Fy is generated at the conducting path 3b. The position y of the conducting path 3b is formulated as follows:

$$F_y = i_2 Bl = IBl\sin(\omega t+\phi)$$

$$y = \frac{IBl}{m}\left\{-\frac{\sin(\omega t+\phi)}{\omega^2} + \frac{\cos\phi}{\omega}t + \frac{\sin\phi}{\omega^2}\right\}$$

It may now be understood that the conducting path 3b performs a simple harmonic motion in the direction of y.

When the conducting paths 3a and 3b are assembled into a conductor and the currents i_1 and i_2 are applied to the conducting paths respectively and alternately, the path of the conductor is formulated as follows:

$$\left(x + \frac{\sin\phi}{\omega}t - \frac{\cos\phi}{\omega^2}\right)^2 + \left(y - \frac{\cos\phi}{\omega}t - \frac{\sin\phi}{\omega^2}\right)^2 = \left(\frac{IBl}{m\omega^2}\right)^2$$

Accordingly, it will be appreciated that the conductor performs a circular motion, that is, it revolves but it does not rotate on its own axis. A force F to be generated at the conductor is a resultant force from the forces Fx and Fy. Thus, the torque is formulated as follow:

$$T = F \times r = \sqrt{F_x^2 + F_y^2} \times r = \sqrt{I^2B^2l^2\left\{\cos^2(\omega t+\phi) + \sin^2(\omega t+\phi)\right\}} \times r = IBlr$$

The principles of electro-magnetism described above are well known, and would be readily recognized by one of ordinary skill in the art. The application of these principles, as

they apply to an embodiment of the present invention, may be found in the specification, beginning on page 6, line 25.

In regard to the Examiner's objection to the drawings and rejections of the claims under 35 USC §§ 101 and 112, applicants feel that, upon understanding the operating principle of the invention, the Examiner will recognize that the figures are adequate as presented, that the invention is useful, and that the specification is sufficient to enable one skilled in the art to make and use the invention.

With respect to the rejections of claim 1 under 35 USC §102, Henry-Baudot fails to teach the following: a movable member that can revolve due to an electromagnetic force, a power supply, and a magnetic field generator, all as recited by claim 1. Henry-Baudot teaches an inductor winding, only (column 1, lines 42-69, and claim 1). Furthermore, in application, a motor incorporating the inductor winding taught by Henry-Baudot, in which current is applied to the coil toward the axial magnetic field, will generate a torque at the rotor, but the torque will only rotate the rotor on its own axis, not revolve it. On the other hand, in the actuator of claim 1, the member revolves due to an electromagnetic force generated by an interaction between a current flowing in the conducting paths and a magnetic field. Thus, the actuator of claim 1 is quite different in motion from Henry-Baudot. Claim 1 is therefore allowable over Henry-Baudot.

For its part, Nishimura fails to teach a "movable member (that) revolves due to an electromagnetic force generated by an interaction between a current flowing in (a plurality of) conducting paths, and a magnetic field generated by (a) magnetic field generator." Rather, the turning scroll 14 (see Figure 2) revolves due to mechanical force exerted by an eccentric coupling with the rotatable shaft 13. In the motor disclosed by Nishimura, application of current to the coil toward the axial magnetic field established by the magnet creates an attraction between the iron core of the exited coil and the magnet. The shaft is rotated by changing in turn a coil to be excited. Claim 1 does not read on Nishimura's motor, and is therefore allowable thereover.

Hojo fails to teach "a plurality of conducting paths which are on a face parallel to a trajectory face of (the) revolution motion" of the movable member, and further fails to teach "a movable member (that) revolves due to an electromagnetic force generated by an interaction between a current flowing in (the) conducting paths, and a magnetic field generated by (a) magnetic field generator. The only magnetic field generated in Hojo's device is produced by

current in the coils 10, and thus there is no movement due to an interaction between the current and the magnetic field. In the motor disclosed by Hojo et al, application of current to the coil 10 creates an attraction between the iron core 9 of the excited coil and the movable scroll 2. The scroll 2 is revolved by changing, in turn, the coil to be excited. Claim 1 is allowable over Hojo.

Clearly, claim 1, and its dependent claims 2-18, are allowable over the cited art.

Henry-Baudot, Nishimura, and Hojo each fail to teach two conducting paths, and so claim 2 is allowable on its own merit, apart from its dependence on an allowable claim.

Henry-Baudot, Nishimura, and Hojo each fail to teach "an outer case made of a magnetic substance for forming an enclosed magnetic path in which magnetic flux occurring from (a) magnet passes. Claim 4 is allowable on its own merit, apart from its dependence on an allowable claim.

Each of claims 6-14 and 16 are also allowable on their own merits, as each claim includes limitations not found in the cited prior art.

With respect to the rejection of claim 19, Henry-Baudot fails to teach "a power supply which flows currents with a phase difference in the plurality of conducting paths," "a magnetic field generator which forms a magnetic field perpendicular to a conducting face formed by said conducting paths," and further fails to teach "wherein either one of the conducting member or the magnetic field generator revolves due to an electromagnetic force generated by an interaction between a current flowing in (a) conducting path and a magnetic field generated by the magnetic field generator." Henry-Baudot teaches only an inductor winding. Claim 19 is allowable over Henry-Baudot.

Nishimura and Hojo each fail to teach "wherein either one of (a) conducting member or (a) magnetic field generator revolves." In Nishimura's device, only the turning scroll 14 revolves. The rotor 27 and shaft 13 rotate, which rotation is converted to revolution by the eccentric coupling between the shaft 13 and scroll 14. The turning scroll is neither a conducting member nor a magnetic field generator.

In Hojo's device, only the movable scroll 2 revolves. The movable scroll is neither a conducting member nor a magnetic field generator, but rather responds with a revolving motion to magnetic attraction successively generated by coils 10. Claim 19 does not read on Nishimura or Hojo, and is therefore allowable thereover.

All amendments to the claims are made to clarify or simplify the respective claims, and do not affect the scope of the claims.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version With Markings to Show Changes Made.**"

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited. In the event the Examiner finds minor informalities that can be resolved by telephone conference, the Examiner is urged to contact applicants' undersigned representative at (206) 622-4900 in order to expeditiously resolve prosecution of this application. Consequently, early and favorable action allowing these claims and passing this case to issuance is respectfully solicited.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The title has been amended to read as follows:

ACTUATOR WITH NON-ROTATING, REVOLVING MEMBER

In the Claims:

Claims1-3, 6, 9-11, 14, and 16-19 have been amended to read as follows:

1. (Amended) A revolution type actuator having a movable member performing a revolution motion, comprising:

a movable member that can revolve with respect to a fixed member;

a plurality of conducting paths which are on a face parallel to a trajectory face of said revolution motion and by which AC currents flow in intersecting directions with a mutual~~ly~~ phase difference in accordance with an angle at which the conducting paths intersect each other;

a power supply which flows currents with a phase difference in said plurality of conducting paths; and

a magnetic field generator which forms a magnetic field perpendicular to said conducting paths;

wherein said movable member revolves due to an electromagnetic force generated by an interaction between a current flowing in said conducting paths, and a magnetic field generated by said magnetic field generator.

2. (Amended) The revolution type actuator according to claim 1,

wherein the plurality of conducting paths is ~~provided~~ equal to two, which intersect with each other at an angle of about 90°; and

currents flowing through said two conducting paths have a phase difference of about 90° therebetween.

3. (Amended) The revolution type actuator according to claim 1, wherein one of the plurality of conducting paths is formed on a printed circuit board.

4. The revolution type actuator according to claim 1, wherein the magnetic field generator includes a magnet, and an outer case made of a magnetic substance for forming an enclosed magnetic path in which magnetic flux occurring from said magnet passes.

5. The revolution type actuator according to claim 1, further comprising a rotation constraining mechanism for holding the movable member on the fixed member in a rotary manner via an eccentric shaft to thereby constrain said movable member from rotating.

6. (Amended) The revolution type actuator according to claim 1, wherein:

~~wherein~~ the magnetic field generator includes a magnet and a stator, which is magnetized by magnetic flux generated by said magnet; and

the movable member is provided with a conductor which is arranged opposite ~~to~~ a magnetic pole of said magnet, in a plane perpendicular to the magnetic flux ~~interposed~~ generated between said magnet~~,~~ and said stator, to thereby form one of the plurality of conducting paths, the moveable member thus revolving due to an electromagnetic force generated by an interaction between a current flowing through said conductor~~conducting path~~ and a magnetic field formed by said magnetic flux.

7. The revolution type actuator according to claim 6, wherein the movable member is entirely or partially made of a magnetic substance.

8. The revolution type actuator according to claim 7, wherein the stator approaches steadily facing to a magnetic substance of the movable member, and has a magnetized face which is perpendicular to said revolving trajectory face.

9. (Amended) The revolution type actuator according to claim 6, wherein the magnet has N- and S-poles on inner and outer peripheries respectively, which are on one face

opposite the movable member, to thereby form a magnetic circuit in which magnetic flux starting from one of said poles enters the stator, thus preventing magnetic flux from leaking to an external space from a face opposite to ~~a~~ the face having both of said poles of said magnet.

10. (Amended) The revolution type actuator according to claim 6,

wherein a magnetic substance is arranged on a pole face of the magnet opposite the movable member and the ~~conducting path~~conductor; and

said magnetic substance has a face thereof opposite said ~~conducting path~~conductor, formed larger in area than a largest revolving region of said ~~conducting path~~conductor and smaller than the pole face, and a face thereof opposite the magnet formed almost as large as said pole face.

11. (Amended) The revolution type actuator according to claim 1, wherein:

~~wherein~~ the movable member is entirely or partially made of a magnet;

the magnetic field generator includes said magnet and a stator which is magnetized by magnetic flux generated by said magnet;

one of the pluralities of ~~the~~ conducting paths is arranged on ~~the~~ a side of the stator opposite ~~to~~ a pole of said magnet of said movable member; and

said movable member is arranged in a plane perpendicular to magnetic flux running between said magnet and said stator, thus revolving due to an electromagnetic force generated by an interaction between a current flowing in the one of the pluralities of ~~said~~ conducting paths and a magnetic field generated by said magnetic flux.

12. The revolution type actuator according to claim 6, wherein a spring is interposed between the movable member and the stator.

13. The revolution type actuator according to claim 12, wherein the spring is provided with a bearing at a tip thereof on the side of the movable member.

14. (Amended) The revolution type actuator according to claim 1, wherein the plurality of conducting paths ~~is~~ are made of a face-shaped conductor.

15. The revolution type actuator according to claim 14,

wherein the face-shaped conductor is provided with a plurality of electrodes; and

the direction of a current flowing through said face-shaped conductor is controlled by sequentially changing said current flowing electrodes.

16. (Amended) The revolution type actuator according to claim 1,

wherein the plurality of conducting paths are comprised of a plurality of sheets of face-shaped conductors which are stacked one on another with insulation maintained therebetween and which are provided with electrodes so as to flow current in different directions; and

wherein said current flowing electrodes can be sequentially changed to thereby control a current flowing through each of said conducting paths, so that the directional electromagnetic force generated by an interaction between said current and said magnetic field may provide a circular motion time-wise.

17. (Amended) The revolution type actuator according to claim 1, wherein:

the actuator has ~~having~~ a configuration of a scroll pump,

~~wherein~~ the movable member is held on said fixed member in a revolutionary manner via an eccentric shaft, ~~;~~ and

said actuator further comprises:

a movable scroll having spiral blades provided to said movable member; ~~and~~

a fixed scroll having spiral blades provided to said fixed member;

said spiral blades of said movable and fixed scrolls ~~are~~ combined with each other; and

wherein said movable scroll is revolved around said eccentric shaft with a predetermined radius to thereby shift an enclosed space formed by said spiral blades of both of

said scrolls from the outside toward the center, thus consecutively reducing the volume of said enclosed space.

18. (Amended) The revolution type actuator according to claim 1, wherein:

the actuator has ~~having~~ a configuration of a scroll pump,

~~wherein~~ the movable member is a first moveable member;

the actuator further comprises a second moveable member ~~provided two, which are~~ the first and second movable members each held to said fixed member in a revolutionary manner via an eccentric shaft;

said first and second movable members are each provided with a movable scroll having spiral blades;

said spiral blades of said movable scrolls are combined with each other; and

said movable scrolls are revolved mutually oppositely with a predetermined radius around said eccentric shaft to thereby shift enclosed space formed by said spiral blades of said movable scrolls from the outside toward the center, thus consecutively reducing the volume of said enclosed space.

19. (Amended) A revolution type actuator, comprising:

a conducting member having a plurality of conducting paths by which currents flow in mutually intersecting directions ~~mutually~~;

a power supply which flows currents with a phase difference in the plurality of conducting paths; and

a magnetic field generator which forms a magnetic field perpendicular to a conducting face formed by said conducting paths,

wherein either one of the conducting member ~~and~~ or the magnetic field generator revolves due to an electromagnetic force generated by an interaction between a current flowing in the conducting path and a magnetic field generated by the magnetic field generator.